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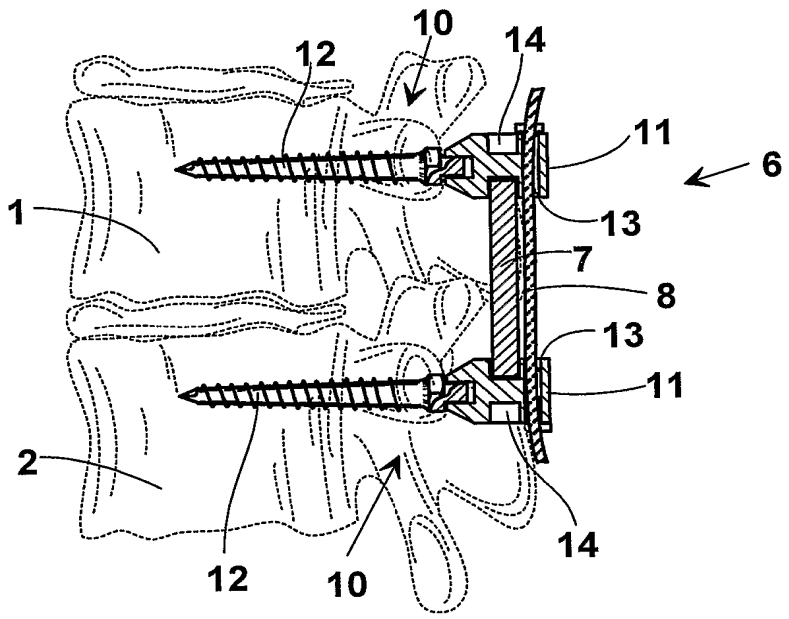
(54) **Title:** MODULAR VERTEBRAL STABILIZER



(57) **Abstract:** Stabilizer (6) of the spinal column adapted to connect to each other at least two adjacent vertebrae (1 and 2) using flexible connection elements that allow for some limited motion to the vertebrae and/or stiff connection elements. The stabilizer (6) comprises an elongated block (7) of predetermined length having two ends operatively connected or compressed between the heads (11) of two screws (12) connected to adjacent vertebrae (1 and 2). The head (11) can be obtained separated from the screw (12) and the head (11) and the screw (12) can be componible together through engaging means. The block (7) can be stiff or flexible. The head (11) can have a first through hole (13) adapted to house a resilient tie-member (8) connected between two heads (11) and adapted to keep the block (7) in position. The head (11) can have a second through hole, at an angle with respect to the first hole (13), said second hole being adapted to house a transversal tie-member connecting diagonally with respect to the spinal column the heads (11)

of two screws being applied to two consecutive vertebrae (1 and 3).

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TITLE

MODULAR VERTEBRAL STABILIZER

DESCRIPTION

Field of the invention

The present invention relates to the medical/surgical field and more precisely it relates to a stabilizer of the spinal column, which is adapted to connect to each other at least two adjacent vertebrae using flexible and/or stiff connection elements that allow for some limited motion to the vertebrae.

Furthermore, the invention relates to a connecting element for stabilizers of the spinal column, in particular flexible or dynamic stabilizers, i.e. that allow for some limited motion to the vertebrae, and/or stiff stabilizers, i.e. that block the movement between at least two vertebrae.

Description of the prior art

Many pathologies relative to the functionality of the spinal column are cured by total or partial immobilization, in particular, with a technique so-called "intervertebral arthrodesis", with the use of connecting means and/or with the addition of portions of bone tissue, which perform a union between such adjacent vertebrae.

In the prior art vertebral stabilizing devices of the type either static or dynamic are known, having a screw adapted to be connected to a vertebra, and stiff elements or elements with limited mobility, having two ends integral to two screws connected to two adjacent vertebrae.

In particular, a dynamic stabilizing device, capable of allowing for a relative movement between the vertebrae that is resiliently limited and blocks an approaching below a predetermined distance, is described in EP0669109 in the name of Dubois. This vertebral stabilizer comprises

a spacing body, resistant to compression and adapted to transfer forces between two screws implanted in respective vertebrae, and a tensioning cord connected between the above described screws and passing in an inner longitudinal recess obtained in said spacing body.

Such a stabilizer has the drawback of being directly assembled locally on the spinal column after having inserted the screws in the vertebrae, with open surgery in a space close to the vertebra. Therefore, there is a high invasivity in the operation on the patient, because enough space has to be created close to the vertebra for carrying out assembling steps, and high difficulty to the surgeon that has to arrange and assemble each single element directly on the vertebrae.

Another drawback of the above described stabilizer is that it does not allow a transversal connection between screws mounted on different vertebrae for transmitting forces in a diagonal direction with respect to the axis of the spinal column.

A further drawback of this device is that the tensioning cord has to be threaded in the spacing body, and this requires a higher effort for the surgeon.

In some cases, furthermore, the need is felt to assemble on a same stabilizer both static portions and dynamic stabilizing portions, creating a hybrid stabilizer, wherein such portions can be chosen by the surgeon according to the characteristics of the pathology.

Furthermore, the need is felt of a vertebral stabilizer that allows the change or the recomposition of some portions of the stabilizer without extracting the screws.

It is furthermore, presently disadvantageous to convert a vertebral dynamic stabilizer into a static stabilizer or vice-versa, without loosening the screws

already implanted in the vertebrae, with a remarkably invasive operation.

Summary of the invention

It is then a feature of the present invention to provide a vertebral stabilizer of dynamic and modular type, adapted to be assembled separately from the spinal column and then mounted on the spinal column in a few seconds.

Another feature of the present invention is to provide a vertebral dynamic stabilizer that allows the transversal connection between adjacent vertebrae, in order to transmit forces in a diagonal direction between screws of adjacent vertebrae, to limit the relative rotation between adjacent vertebrae, such as for pathologies with vertebral rotation like scoliosis and congenital and acquired vertebral rotations.

A further feature of the present invention is to provide a stiff vertebral stabilizer, adapted to be assembled separately from the spinal column and then mounted on the spinal column very quickly.

It is another feature of the present invention to provide a vertebral stabilizer for converting a dynamic stabilizer into a static stabilizer without loosening the screws already implanted in the vertebrae.

Another feature of the present invention is to provide a stiff vertebral stabilizer that allows the connection to a vertebral dynamic stabilizer, giving rise to a hybrid stabilizer.

These and other objects are achieved by a vertebral stabilizer comprising:

- an elongated block, having two ends and a predetermined length extending between said two ends;
- a screw adapted to be put in a vertebra, said screw

having a head;

- means for keeping said block compressed between two of said heads in order to keep said screws at a predetermined distance from each other,

wherein said head is separated from said screw, said head and said screw being componible together by engagement means provided between said head and said screw.

In particular, said engagement means comprises a connection selected from the group comprised of:

- a click engagement comprising resilient engagement means;
- an engagement with threaded surfaces;
- by screws;
- a bayonet coupling;
- a retainer means.

According to another aspect of the invention, such objects are achieved by a vertebral stabilizer comprising:

- a resilient flexible tie-member, in particular, a wire, capable of bearing a predetermined tension;

wherein said through hole and said housing are made in said head such that said block is kept compressed between two of said heads, said block having its ends engaging with the respective housings in order to keep said screws at a predetermined distance from each other, said wire resulting stretched between said two heads and external to said block.

This way, the operations are simpler of assembling the block between two heads, it being unnecessary to thread the wire in the spacing element.

In particular, said first through hole is made in said housing and said block has a longitudinal channel adapted to receive said tie-member parallel to said block.

Alternatively, said through hole is obtained in said head outside of said housing.

In a preferred exemplary embodiment, said head has two housings for engagement of the block made on two opposite faces of said heads.

Advantageously, said head comprises at least one second through hole, at an angle with respect to said first hole, incident to the axis of said screw, said second hole being adapted to house a transversal connecting tie-member, diagonally with respect to the spinal column, the heads of two of said screws being applied to two adjacent vertebrae. This way, said transversal tie-member does not apply any torque to said head avoiding the rotation of the head same.

Advantageously, means are provided for fastening said resilient flexible tie-member and said resilient transversal tie-member to said head, by making an enlargement on said wire that prevents it from passing through said hole.

In particular, said fastening means, by making an enlargement on the wire, are selected from the group comprised of:

- at least one deformed ring clamped about said wire, said ring penetrating partially in the cross section of said wire when plied;
- a tubular element deformable by compression;
- a deformable element having teeth capable of penetrating in the cross section of said wire when said element is squeezed;
- a snap-hook that can be clamped on said wire;
- a knot;
- an enlargement of the wire by plastic deformation.

In an alternative exemplary embodiment, said fastening means comprises at least one screw gripping said wire.

In a particular exemplary embodiment, said head comprises a countersunk portion or enlarged opening at

least at one end of said through hole, said countersunk portion being adapted to contain said fastening means, once applied to said pulling element, so that said fastening means are capable of entering said countersunk portion but not of passing through said hole.

Advantageously, said elongated block is made of resilient and flexible material.

In particular, said elongated block has shape selected from the group comprised of:

- a prismatic body having a substantially rectangular base with a longitudinal channel made on a outer side surface;
- a prismatic body having a substantially rectangular base with a longitudinal channel made on both larger side surfaces;
- a prismatic body having base substantially as a half circular crown;
- two prismatic bodies parallel to each other, in particular, substantially cylindrical, connected by a narrow strip;
- two prismatic bodies parallel to each other, substantially cylindrical, different from each other.

In an advantageous exemplary embodiment, said head is obtained separated from said screw, said head and said screw being componible together by engagement means provided between said head and said screw.

This way, the surgeon can implant the screws on the bone tissue in the predetermined position. Then, the surgeon can put on the screws, which are suitably kept distant from each other, the heads with the relative block and wire tie-member being suitably tensioned.

It is thus possible, for the surgeon, to pre-assemble the heads, with the relative block and with the tensioned

wire, apart from the operation field, reducing the operation to the simple application of the screws, to their distancing and to snap fitting the pre-assembled parts. This solution is surgically advantageous and limits to the minimum the duration of the operation on the patient.

In an advantageous exemplary embodiment, said head comprises at least one second through hole, at an angle with respect to said first hole, incident to the axis of said screw, said second hole being adapted to house a transversal tie-member connecting diagonally with respect to the spinal column the heads of two of said screws being applied to two adjacent vertebrae.

According to another further aspect of the invention, the above described objects are achieved by a vertebral dynamic stabilizer comprising:

- an elongated block, having two ends and a predetermined length extending between said two ends;
- a screw adapted to be put in a vertebra, said screw having a head having a first through hole and at least one housing at one end of said block;
- a resilient flexible tie-member, in particular, a wire capable of bearing a predetermined tension;

wherein said through hole and said housing are made in said head such that said block is kept compressed between two of said heads, said block having its ends engaging with the respective housings in order to keep said screws at a predetermined distance from each other, said wire resulting stretched between said two heads, wherein said head comprises at least one second through hole, at an angle with respect to said first hole, incident to the axis of said screw, said second hole being adapted to house a transversal tie-member connecting diagonally with

respect to the spinal column the heads of two of said screws being applied to two adjacent vertebrae.

Advantageously, said head is obtained separated from said screw, said head and said screw being componible together by engagement means provided between said head and said screw.

According to a further aspect of the invention, a vertebral stabilizer according to the invention comprises:

- an elongated block, having two ends and a predetermined length extending between said two ends;
- a screw adapted to be put in a vertebra, said screw having a head having at least one housing at one end of said block;
- said housing being made in said head such that said block is kept compressed between two of said heads, said block having its ends engaging with the respective housings in order to keep said screws at a predetermined distance from each other;
- said head having means for locking said block in said housing;
- said head being obtained separated from said screw, said head and said screw being componible together by engagement means provided between said head and said screw.

In a way similar to the case as above defined, it is thus possible for the surgeon to pre-assemble the heads with the relative block tightened apart from the operation field, even without wires, reducing the operation to the simple application of the screws, to their distancing and to snap fitting the pre-assembled parts.

Advantageously, said head has a hole for passage of a resilient flexible tie-member, in particular, a wire capable of bearing a predetermined tension and an

enlargement of closure on the other hand. This way, the head can house at the same time a flexible block, on one side, and a stiff block, on the other side, forming a hybrid equipment.

Brief description of the drawings

The invention will be made clearer with the description of some its exemplary embodiments, exemplifying but not limitative, with reference to the attached drawings wherein:

- Figure 1 shows a front view of an example of application of a dynamic stabilizer, according to the invention, to three adjacent vertebrae;
- Figure 2 shows a cross sectional view made with a longitudinal plane, of a dynamic stabilizer according to the invention, mounted on two consecutive vertebrae;
- Figure 3 shows a cross sectional view of two such stabilizers applied to a spinal column;
- Figure 4 shows an exploded view of a stabilizer according to the invention;
- Figure 5 shows a preferred exemplary embodiment of such a stabilizer;
- Figure 6 shows, a longitudinal cross section of an exemplary embodiment of the present invention, which shows how the heads, the block and the wire can be pre-assembled together independently from the screws;
- Figures 7 A,B show respectively a view and a cross sectional view of an exemplary embodiment of a screw and a head with through hole out of the housing, mounted together of the stabilizer;
- Figures 8 A,B show respectively a view and a cross sectional view of another exemplary embodiment of a screw and a head, with through hole in the housing;

- Figure 9 shows a front view of an example of application of three vertebral stabilizers with transversal pulling elements arranged between two consecutive vertebrae;
- Figure 10 shows a front view of an example of application of vertebral stabilizers with transversal pulling elements arranged along three consecutive vertebrae;
- Figure 11 shows a front view of a further example of application of vertebral stabilizers where two stabilizations of vertebral rotation having the same direction are required;
- Figures 12 A-C and 13 A-C show an elevational and a cross sectional view of two possible exemplary embodiments of screw and head with a second through hole adapted to house a transversal tie-member;
- Figure 14 shows a perspective view of a possible exemplary embodiment of a block according to the invention;
- Figures from 15 to 22 show cross sectional views of respective exemplary embodiments of a block and the corresponding relative position of a pulling element;
- Figure 23 shows a front view of an example of application of a stabilizer, according to the invention, to three adjacent vertebrae;
- Figure 24 shows an exemplary embodiment of application of a stabilizer, according to the invention, to three adjacent vertebrae, by a stabilizer hybrid consisting of a combination of a dynamic stabilizer and a static stabilizer;
- Figure 25 shows a cross sectional view made with a longitudinal plane of a stabilizer according to the invention, mounted on two consecutive vertebrae;

- Figure 26 shows a cross sectional view of two such stabilizers applied to a vertebra;
- Figure 27 and 28 show respectively an exploded view and a perspective view of a further example of stabilizer according to the invention;
- Figures 29-32 show a cross sectional view of some possible exemplary embodiments of a head of a screw according to the invention, with one or two recesses adapted to retain a stiff block;
- Figure 33, 34, and 35 show respectively a cross sectional, top plan and a perspective view of an exemplary embodiment of a head adapted to fasten both a stiff block, with function of static stabilizer, and an an elongated block with resilient flexible tie-member with function of dynamic stabilizer, to provide the configuration of figure 24.

Description of preferred exemplary embodiments.

In the following description an example will be illustrated of a stabilizer of the spinal column according to the invention, adapted to connect to each other at least two adjacent vertebrae using flexible connection elements, that allow for some limited motion to the vertebrae and/or using stiff connection elements. In particular, the stabilizer, if required by the pathology, such as scoliosis and vertebral rotation, connects also diagonally two adjacent vertebrae, controlling thus the relative rotation of the vertebrae. In this connection, figure 1 shows two couples of stabilizers 50 and 60 applied to a spinal column 4 and, in particular, to three consecutive vertebrae 1, 2 and 3.

The stabilizers 50 and 60 comprise blocks 7 mounted and compressed between heads 11 by external resilient pulling elements 8.

Figure 2 shows a cross sectional view of a vertebral dynamic stabilizer 6 according to the invention, mounted on two adjacent vertebrae 1 and 2. Stabilizer 6 comprises two screws 12 applied respectively to vertebrae 1 and 2, each screw 12 supporting a respective head 11 having one or two opposite housings 14 at the end of a block 7. Heads 11 have a through hole 13 for a resilient flexible tie-member 8 to pass through, which tie-member, after having been tensioned between heads 11, is retained by a deformable ring 9 clamped on each tie-member end.

As shown in figure 6 and 28, each head 11 has a housing 17 adapted to house the end 16 of screw 12. The shapes of the end 16 of screw 12 and of the housing 17 of head 11 are complementary and adapted to provide a snap engagement or another releasable connection, with means known in the art and not shown in detail.

Such a system allows to implant screws 12 independently from stabilizer 50. This way, the assembling steps can be made separately, respecting the relative positions of screws 12, and applied once assembled so that each head 11 is connected to a respective screw 12. This way, a less invasive assembling process is obtained with respect to the known systems, since the existing implant screws that are integral with the respective heads force the components of the stabilizer directly on the spinal column, with the need of a large open operation field owing to complex assembling operations.

Figure 3 shows a cross sectional view of two stabilizers 6 applied to two adjacent vertebrae of a spinal column, of which a vertebra 1 is visible. Screws 12 have to be implanted in order to remain completely in the bone avoiding the risk of affecting the bone marrow. In figure 3, each head 11 is shown with an opening 14, a wire 8 and a deformed locking ring 9 for blocking wire 8 in order to

prevent it from passing through head 11.

Figure 4 shows an exploded view of a stabilizer 6 according to the invention, comprising two screws 12 separate from two heads 11 having two housings 14 adapted to engage with the ends of a block 7, and a through hole 13 adapted to let a flexible resilient tie-member 8 to pass through, which can be fixed on said heads 11, once threaded in the hole, by means of two deformable rings 9 connected to the ends of the tie-member.

In figure 5, the above described stabilizer is shown mounted, as it is when it is mounted on the vertebrae not shown in the figure.

Figure 6 shows a cross sectional view of a vertebral dynamic stabilizer as described in figures 2-5, with heads 11, with the relative block 7 and tensioned wire 8, which the surgeon has pre-mounted before applying it to the corresponding screws 12, previously implanted in the vertebrae. The block has been previously cut to a suitable length adapted to set a determined distance between the screws. The two heads 11 are then arranged aligned and distanced from the block, whose ends engage with the respective housings 14. The wire tie-member 8 is suitably blocked in a direction making a first enlargement, so that the wire does not pass further through one of the holes 13 of heads 11. Then the wire is tensioned and blocked also in the other direction making a second enlargement, so that the wire does not pass further through the other hole 13 of head 11.

Then, the surgeon starts the operation by arranging screws 12 in the vertebrae. Once implanted, the screws will be at a distance less than a desired distance, since the operation is necessary because certain vertebrae are too close to one another, owing to known pathologies. The surgeon, then, will bring them to a desired distance, by

means of suitable toolings, where the distance is the same that would be imposed by the presence of blocks 7. Then, the surgeon will proceed to snap fitting the pre-assembled parts, that, separately from the operation field had been already prepared so that the heads of the screws are fixed by the blocks at that exact distance. This solution is of huge advantage from a surgical viewpoint and limits to the minimum the duration of the operation on the patient.

In figures 7 A,B is shown an elevational and a cross sectional view of a screw 12 and head 11 of a stabilizer according to the invention, where screw and head are shown mounted together. Head 11 comprises two housings 14 adapted to contain the ends of corresponding blocks not shown, a through hole 13, out of housings 14, adapted to house a tie-member 8 blocked by a deformed ring 9, a housing 17 adapted to house a head 16 of screw 12.

Similarly, in figure 8 A-B another exemplary embodiment is shown of screw 12 and head 11, where head 11 comprises a through hole 13 in housings 14, so that the end of the tie-member 8 remains operatively hidden in the above described housing 14, with deformed ring 9.

In figure 9 an example is shown of two couples of stabilizers 50 and 60 assembled on three vertebrae not shown, where said stabilizers require diagonal pulling elements 22 adapted to transmit forces between two adjacent vertebrae, but in a direction different from the axis of the spine, for stabilizing the vertebrae to limit rotation. The stabilizers 50 and 60, as shown in the previous figures, comprise blocks 7 engaged between the heads 21 and the pulling elements 8.

Similarly, figure 10 shows another example of assembling two couples of stabilizers 50 and 60, where diagonal pulling elements 22 are provided on three adjacent vertebrae, not shown.

Figure 11 shows a front view of a further example of application of vertebral stabilizers where two stabilizations of vertebral rotation are required having the same direction.

Figures 12 A-C show an elevational view and a cross sectional view of a possible exemplary embodiment of screw 12 and head 21, which, besides having a through hole 13 for a longitudinal tie-member not shown, has a second through hole 18, adapted to house a transversal tie-member not shown in the figure. In particular, the axis of hole 18 is incident with the axis of hole 13 in a point belonging to the axis of screw 12, so that the forces applied to head 21, by the pulling elements not shown, do not generate torque actions about axis said screw 12.

Similarly, figures 13 A-C show, in a cross sectional and elevational view, a screw 12 with a head 31, having in addition to through hole 13, a second through hole 18 parallel to first hole 13, adapted to house a diagonal tie-member 22 as shown mounted in figure 10.

In figure 14 a perspective view is shown of a possible exemplary embodiment of a block 7, having a channel 41 for passage of a tie-member not shown in the figure.

Figures from 15 to 22 show different alternative exemplary embodiments of a block according to the invention. In particular, figures 14 and 15 refer to a block 7 substantially parallelepiped, having a channel 41 for a longitudinal tie-member 8. Figures 16 and 17 show two further exemplary embodiments of a block 7 having a cross section consisting of two substantially cylindrical portions having two opposite channels 41 and 42. Figure 7 shows a cross sectional view with two semicylinders 45 and 46 distinct from a channel 41 for tie-member 8.

Figures 20 and 21 show two exemplary embodiments with half circular crown cross section blocks 47 with a channel

41 for tie-member 8. A further exemplary embodiment is shown in figure 22 where block 7 comprises two parallel distinct cylinders 48 and 49, parallel to tie-member 8.

Notwithstanding in the description reference has been made to the solution of heads 11 of screws 12 separable from each other, this solution is to be considered an advantageous but not limitative function.

Furthermore, notwithstanding in the description reference has been made to wire 8 located out of block 7, it is also possible that block 7 is pierced and the wire passes through it.

Figure 23 shows one alternative exemplary embodiment of stabilizers of stiff type 50 according to the invention, applied to a spinal column 4, in particular, to consecutive vertebrae 1, 2, 3, having stiff blocks 49 mounted between heads 11 and locked to them.

In figure 24, instead, a hybrid stabilizer is shown, according to the invention, which uses a stiff stabilizer 50 associated to a dynamic stabilizer 150 having an elongated resilient block 7 with resilient flexible tie-member 8. In particular, stabilizers 50 and 150 comprise, to this purpose, heads 11 for fixing respectively stiff blocks 49, and elongated resilient blocks 7 with resilient flexible tie-member 8 blocked as described hereinafter.

With reference to figure 2,4, central head 11 can be a universal head, suitable to stiff connections, and to resilient connections, and to both, i.e. hybrid connections, which serve as "trait of union" for both.

Figures from 25 to 28 show the "modular" aspect of the stiff vertebral stabilizer 50 according to the invention, mounted on two adjacent vertebrae 1 and 2. This stabilizer 50 comprises two screws 12 applied respectively to vertebrae 1 and 2, each screw 12 supporting a respective head 11, which has one or two opposite housings 14 for

engagement of the ends of block 49. Heads 11 have a hole 57 for locking the block by a small screw 53. In particular, small screw 53 enters transversally in the housing 14 and penetrates stiff block 49, made of metal for example of titanium, to ensure an interference that avoids an extraction by accident.

In particular, each head 11, like in the cases described above and in figure 28, has a housing 17 adapted to snap engage the end 16 of screw 12. This feature allows also to interchange easily head 11 by an operation located and of convert a dynamic stabilizer into a static stabilizer or vice-versa, or in an hybrid stabilizer, without unscrewing the screws already implanted in the vertebrae.

The same can be said when one of the two heads 11 is of hybrid type, i.e. it can receive on one side a stiff block 49 and on the other side a resilient block 7.

As shown in figure 26, where a cross sectional view is illustrated of two stabilizers 50 applied to two adjacent vertebrae of a spinal column, screws 12 have to be implanted, in a known way, and remain completely in the bone and far from the axis of the spinal column, avoiding thus the risk of affecting the bone marrow. In figure 25, each head 11 is shown having opening 14.

As shown in detail in figures 27 and 28, block 49, having ends 51 and 52 retained by small screws 53 in respective housings 14 of two heads 11, has a length substantially the same as the predetermined distance between screws 12 and is adapted for a positive engagement with them. This way, stabilizer 50 has the advantages of modularity and ensures an appropriate stiffness, as can be necessary for certain pathologies of the spine. The heads of the screws can be made in the many ways indicated in figures from 29 to 32.

Figures from 29 to 32 show indeed in cross sectional views some possible exemplary embodiments of a head of a screw according to the invention, with one or two recesses adapted to fasten a stiff block. Figure 29 shows a head 11 of a screw having two opposite recesses 14 with respective fastening screws 53. This head allows to connect to each other two stiff blocks not shown to a same vertebra, then it has a connection function. Figures 30 and 31 show two exemplary embodiments of a head 11 having a single recess 14 respectively longer and shorter, having a fastening screw 53.

Figure 32 shows a head 11 of a screw according to the invention having two opposite recesses 14 with respective fastening screws 53 corresponding to stiff blocks not shown, and a through hole 13 fo passage of a resilient flexible tie-member not shown. This exemplary embodiment is related either to the use of head 11 for fastening two stiff blocks 49 using recess 14 and the screws 53, or alternatively, to connect a resilient block 7 with a flexible tie-member 8 passing through hole 13, without using fastening screws 53.

Figures 33, 34 and 35 show a head 11 capable of supporting at the same time a stiff block 49 and a resilient block 7 compressed by a resilient flexible tie-member 8, forming a hybrid stabilizer. The stiff block 49 is connected by screw 53 and flexible tie-member 8 with screw 54. Hole 13 is advantageously curved for allowing a quick introduction of the tie-member 8 from a side face of the head.

The foregoing description of a specific embodiment will so fully reveal the invention according to the conceptual point of view, so that others, by applying current knowledge, will be able to modify and/or adapt for

various applications such an embodiment without further research and without parting from the invention, and it is therefore to be understood that such adaptations and modifications will have to be considered as equivalent to the specific embodiment. The means and the materials to realise the different functions described herein could have a different nature without, for this reason, departing from the field of the invention. It is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation.

CLAIMS

1. A vertebral stabilizer comprising:
   - an elongated block having two ends and a predetermined length extending between said two ends;
   - a screw adapted to be put in a vertebra, said screw having a head;
   - means for keeping said block compressed between the two screws in order to keep said screws at a predetermined distance from each other,

   characterised in that

   said head is separated from said screw, said head and said screw being componible together by engagement means provided between said head and said screw.

2. A vertebral stabilizer, according to claim 1, wherein said engagement means comprises a connection selected from the group comprised of:
   - a click engagement comprising resilient engagement means;
   - an engagement with threaded surfaces;
   - by screws;
   - a bayonet coupling;
   - a retainer means.

3. A vertebral stabilizer according to claim 1, comprising a resilient flexible tie-member, in particular, a wire, capable of bearing a predetermined tension, characterised in that said head has a first through hole and said tie-member is stretched between said heads of said two screws.

4. A vertebral stabilizer according to claim 1, wherein said tie-member is external to said block.

5. A vertebral stabilizer according to claim 1, wherein said head has at least one housing at one end of said

block, said through hole and said housing being made in said head such that said block is kept compressed between two of said heads, said block having its ends engaging with the respective housings in order to keep said screws at a predetermined distance from each other.

6. A vertebral stabilizer, according to claim 3, wherein said first through hole is made in said housing and said block has an open longitudinal channel adapted to receive said tie-member parallel to said block.

7. A vertebral stabilizer, according to claim 3 and claim 5, wherein said first through hole is obtained in said head outside of said housing.

8. A vertebral stabilizer, according to claim 3, wherein said head has two housings made on two opposite faces of said heads for engagement of the block.

9. A vertebral stabilizer, according to claim 3, wherein said head comprises at least one second through hole, at an angle with respect to said first hole, incident to an axis of said screw, said second hole being adapted to house a transversal connecting tie-member, diagonally with respect to the spinal column, the heads of two of said screws being applied to two adjacent vertebrae.

10. A vertebral stabilizer, according to claim 3 or 9, wherein means are provided for fastening to said head said resilient flexible tie-member with respect to said first hole or said resilient transversal tie-member to said second hole.

11. A vertebral stabilizer, according to claim 10, wherein said fastening means are adapted to make an enlargement on the wire and are selected from the group

comprised of:

- at least one deformed ring clamped about said wire, said ring penetrating partially in the cross section of said wire when plied;
- a tubular element deformable by compression;
- a deformable element having teeth capable of penetrating in the cross section of said wire when said element is squeezed;
- a snap-hook that can be clamped on said wire;
- a knot;
- an enlargement made by plastic deformation of the wire.

12. A vertebral stabilizer, according to claim 3 or 9, wherein said fastening means comprises at least one screw gripping said wire.

13. A vertebral stabilizer, according to claim 3, wherein said elongated block has shape selected from the group comprised of:

- a prismatic body having a substantially rectangular base with a longitudinal channel made on a outer side surface;
- a prismatic body having a substantially rectangular base with a longitudinal channel made on both larger side surfaces;
- a prismatic body having base substantially as half circular crown;
- two prismatic bodies parallel to each other, in particular, substantially cylindrical, connected by a narrow strip;
- two prismatic bodies parallel to each other, substantially cylindrical, separated from each other.

14. Vertebral stabilizer according to claim 3, wherein

said hole for passage of a resilient flexible tie-member is made between a front face, in line with said block, and a face side, for introducing said wire from a side face.

15. A vertebral dynamic stabilizer comprising:

- an elongated block, having two ends and a predetermined length extending between said two ends;
- a screw adapted to be put in a vertebra, said screw having a head having a first through hole and at least one housing at one end of said block,
- a resilient flexible tie-member, in particular, a wire capable of bearing a predetermined tension;

wherein said through hole and said housing are made in said head such that said block is kept compressed between two of said heads, said block having its ends engaging with the respective housings in order to keep said screws at a predetermined distance from each other, said tie-member resulting stretched between said two heads,

characterised in that:

said head comprises at least one second through hole, at an angle with respect to said first hole, incident to the axis of said screw, said second hole being adapted to house a transversal tie-member connecting diagonally with respect to the spinal column the heads of two of said screws being applied to two consecutive vertebrae.

16. A vertebral dynamic stabilizer comprising:

- an elongated block, having two ends and a predetermined length extending between said two ends;
- a screw adapted to be put in a vertebra, said screw having a head having a first through hole and at least one housing at one end of said block,
- a resilient flexible tie-member, in particular, a wire, capable of bearing a predetermined tension;

characterised in that:

said through hole and said housing are made in said head such that said block is kept compressed between two of said heads, said block having its ends engaging with the respective housings in order to keep said screws at a predetermined distance from each other, said tie-member resulting stretched between said two heads and external to said block.

17. A vertebral dynamic stabilizer comprising:

- an elongated block, having two ends and a predetermined length extending between said two ends;
- a screw adapted to be put in a vertebra, said screw having a head having a first through hole and at least one housing at one end of said block,
- a resilient flexible tie-member, in particular, a wire capable of bearing a predetermined tension;

wherein said through hole and said housing are made in said head such that said block is kept compressed between two of said heads, said block having its ends engaging with the respective housings in order to keep said screws at a predetermined distance from each other, said tie-member resulting stretched between said two heads,

characterised in that:

said head comprises at least one second through hole, at an angle with respect to said first hole, incident to the axis of said screw, said second hole being adapted to house a transversal tie-member connecting diagonally with respect to the spinal column the heads of two of said screws being applied to two consecutive vertebrae.

Fig.1

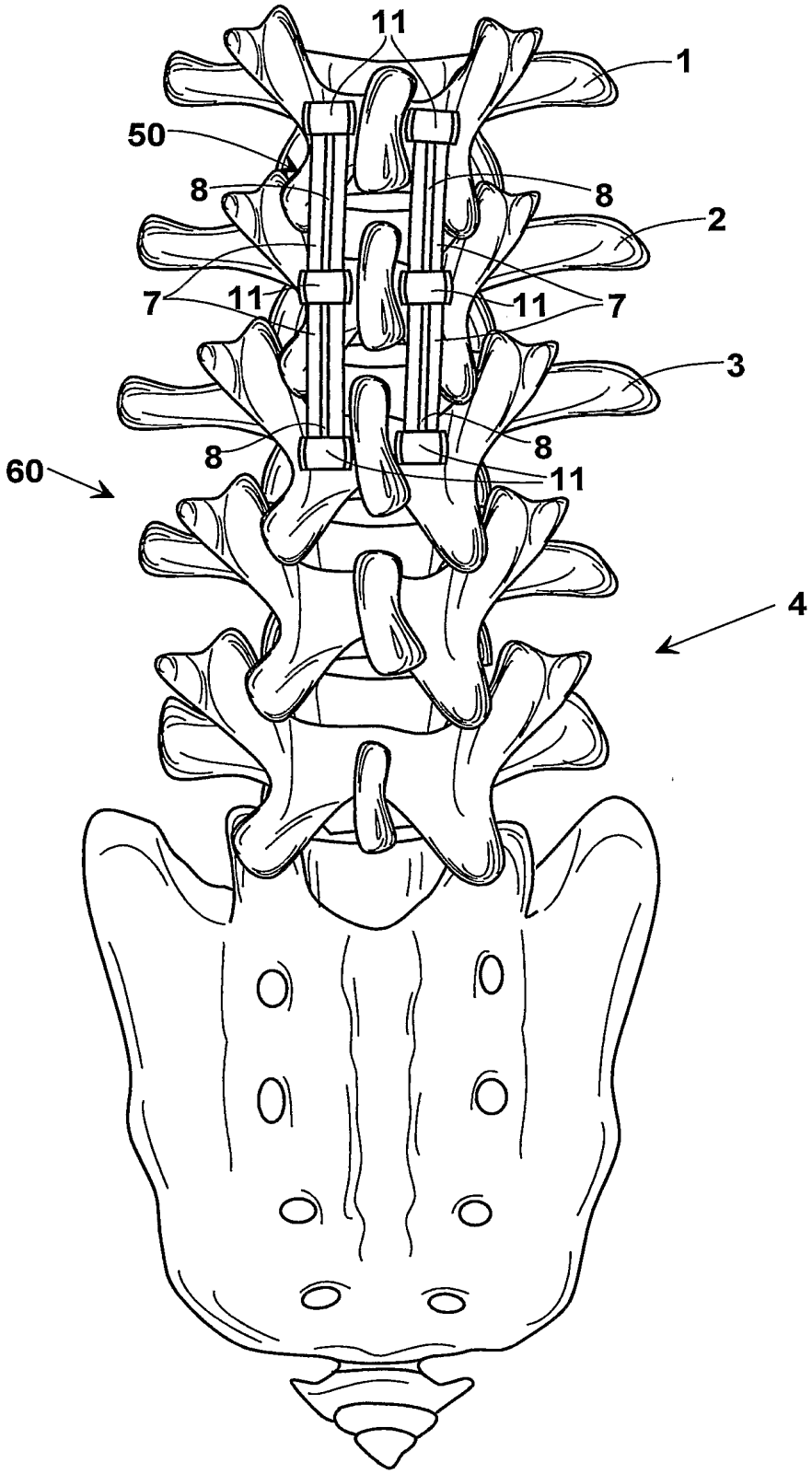


Fig.2

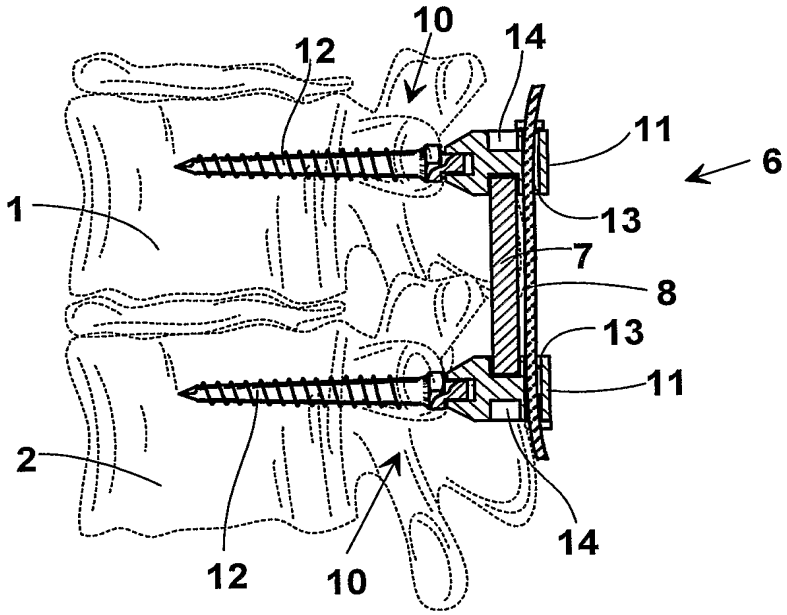


Fig.3

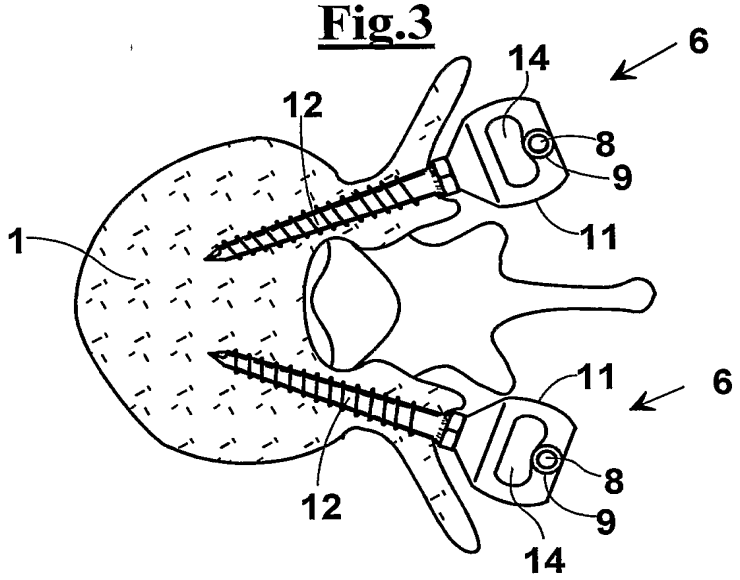


Fig.4

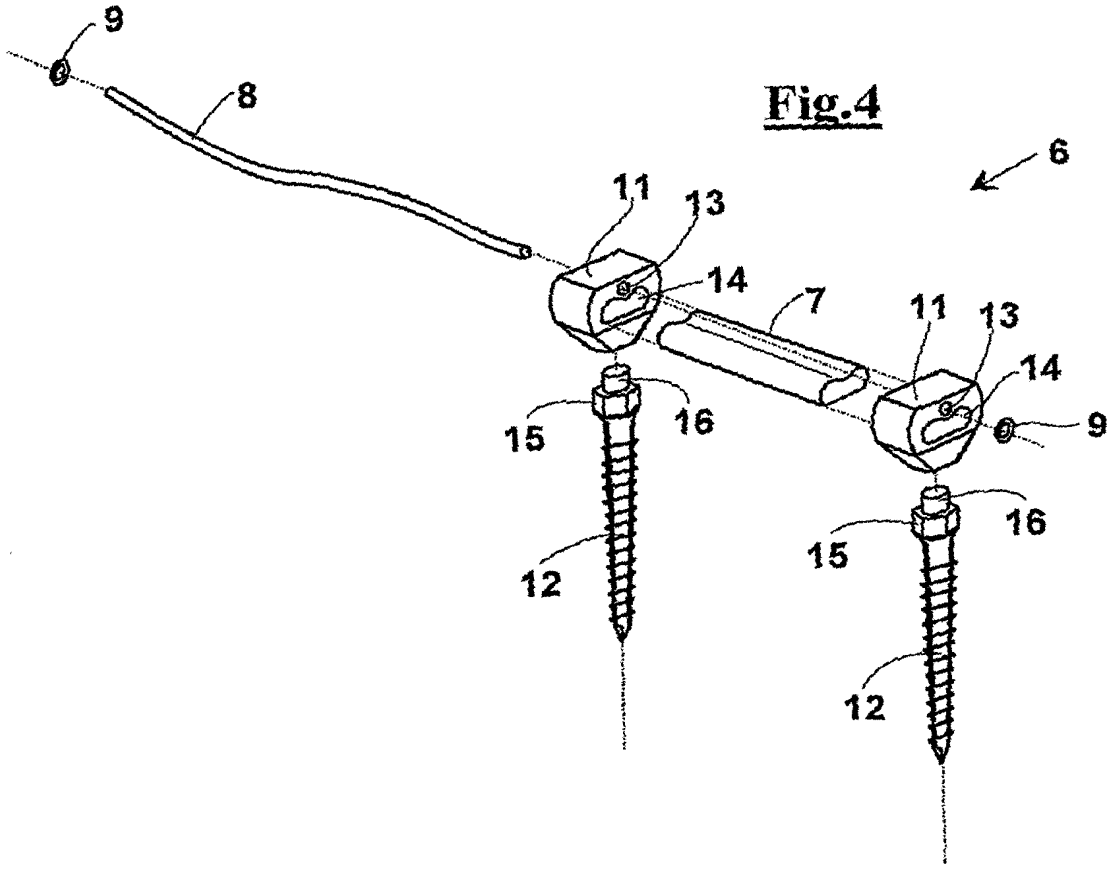


Fig.5

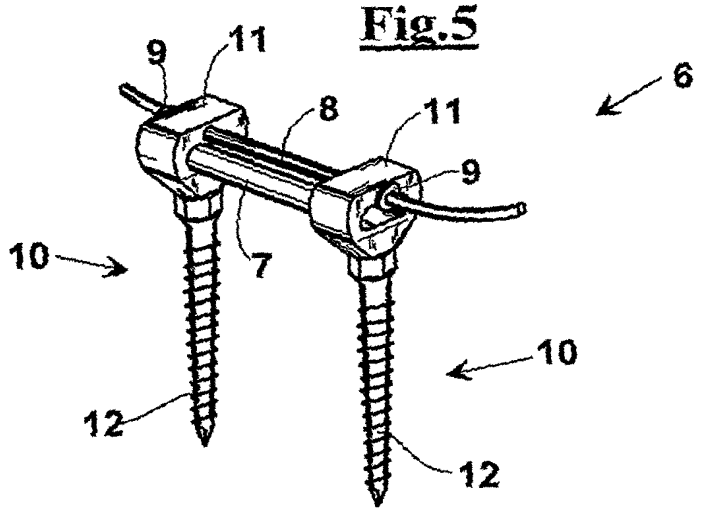


Fig.6

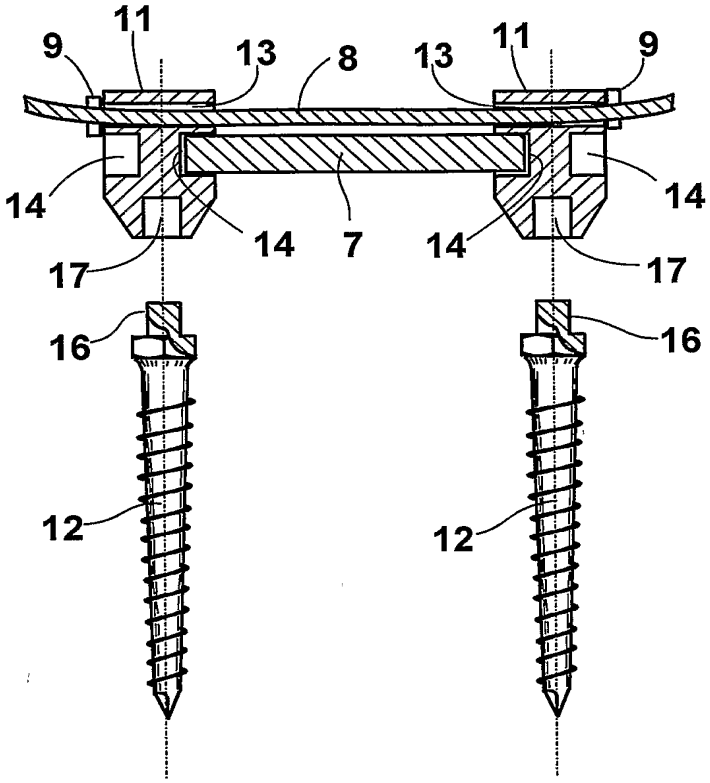


Fig.7A

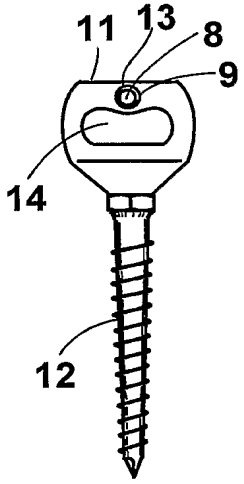


Fig.7B

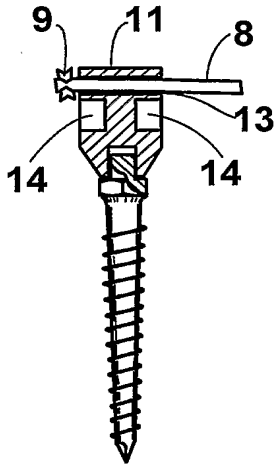


Fig.8A

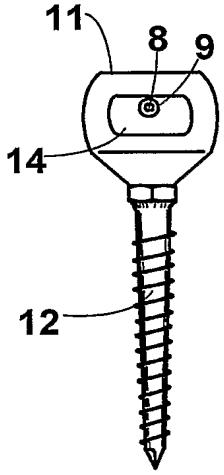


Fig.8B

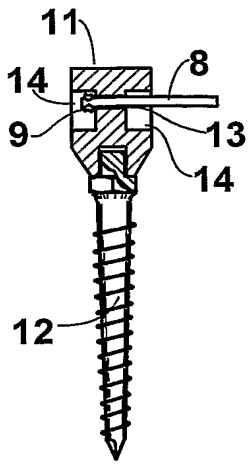


Fig.9

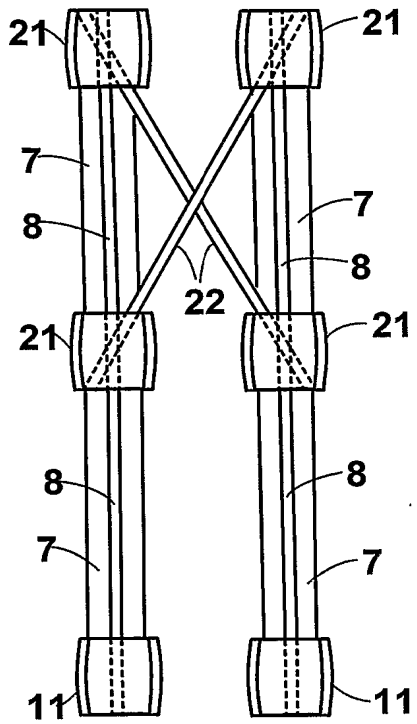


Fig.10

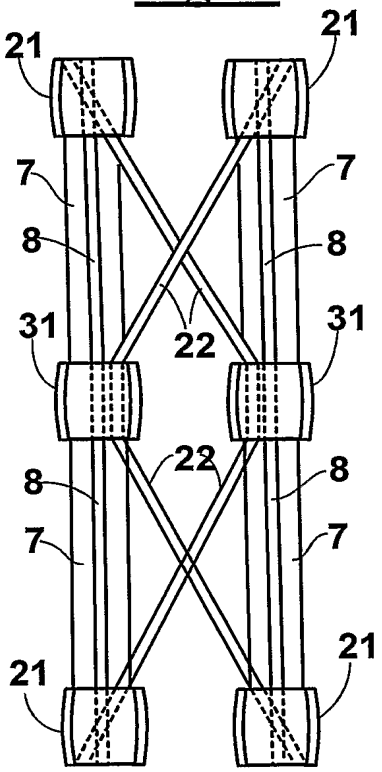


Fig.11

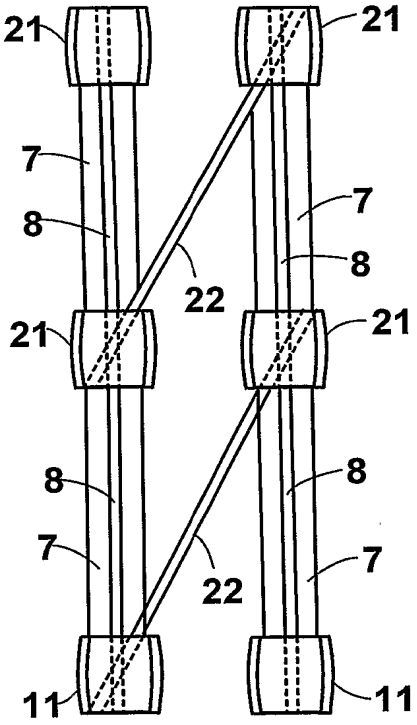


Fig.12C

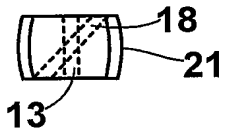


Fig.13C

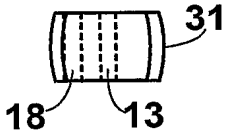


Fig.12A

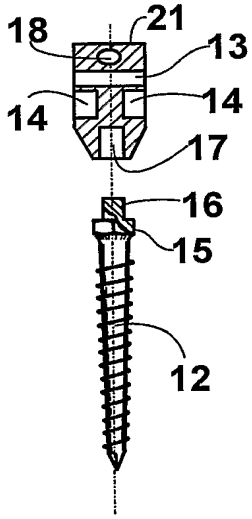


Fig.12B

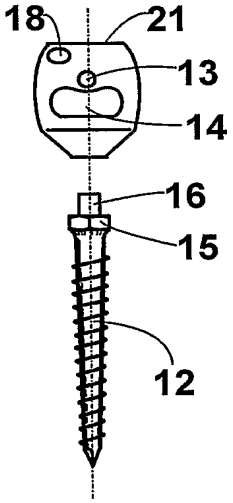
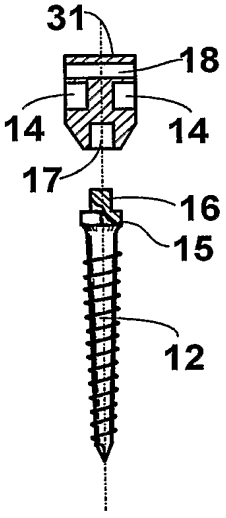


Fig.13A



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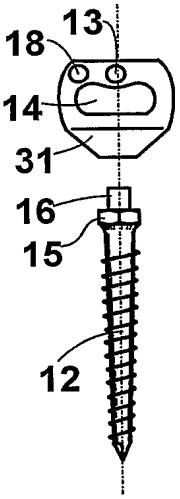
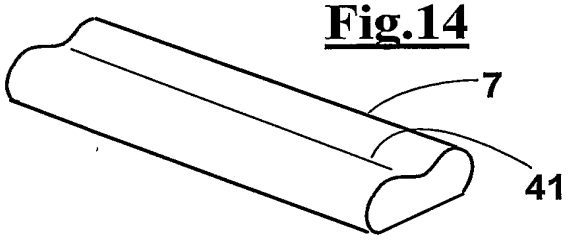


Fig.14



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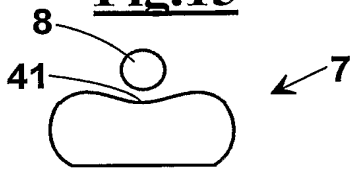

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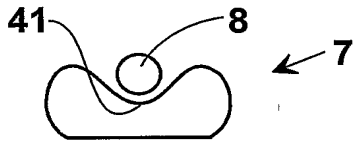

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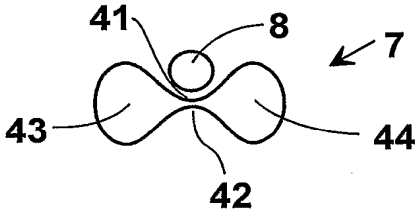

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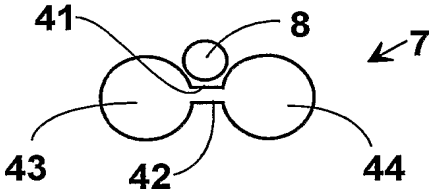

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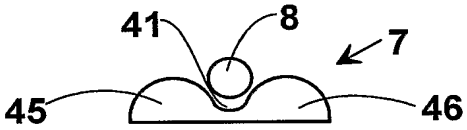

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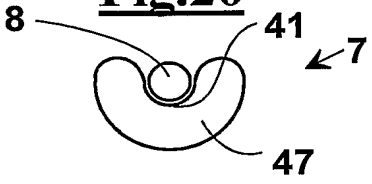

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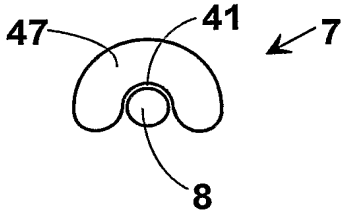

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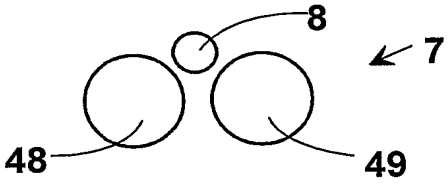

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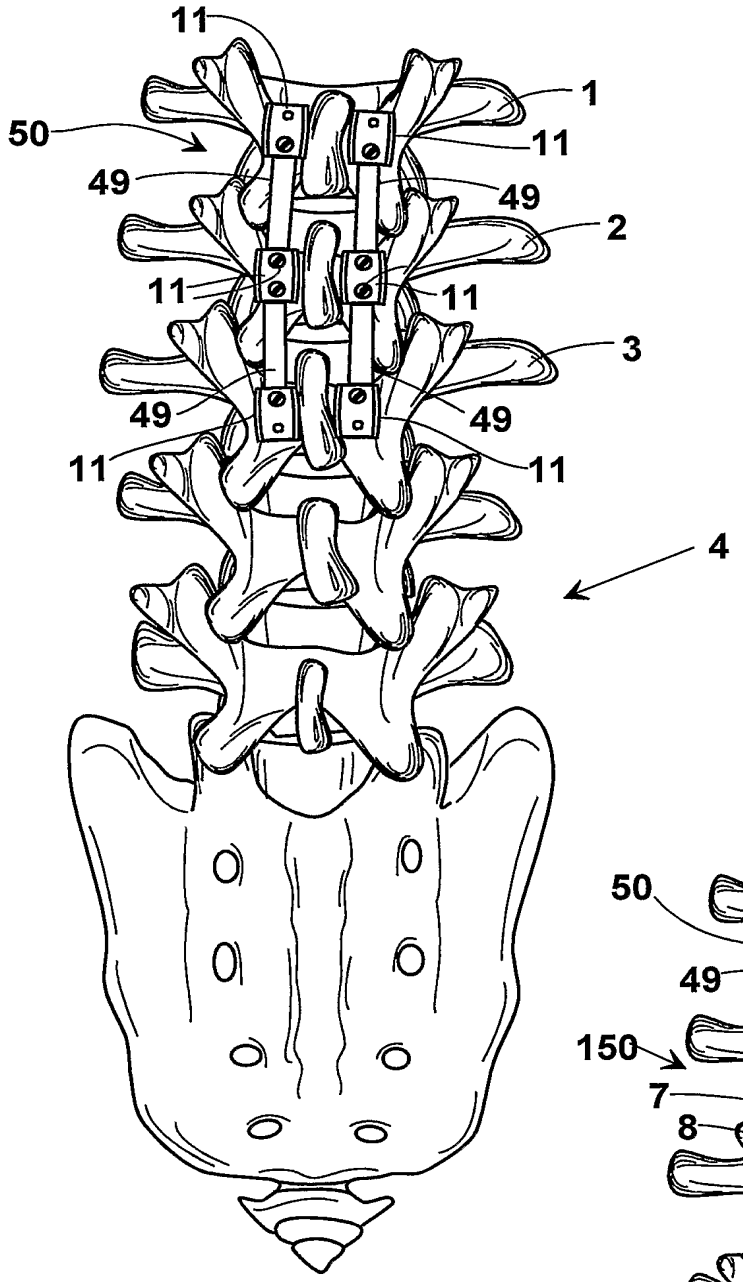
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Fig.24

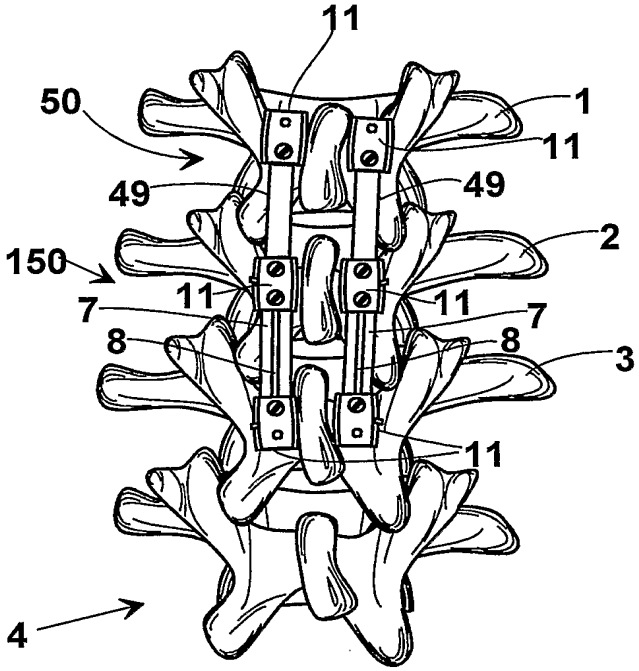
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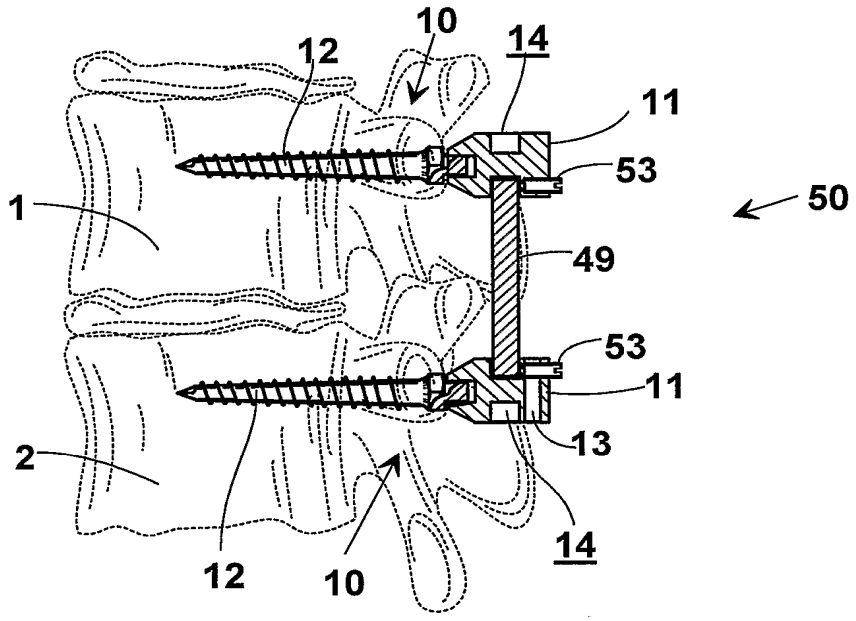
Fig.25



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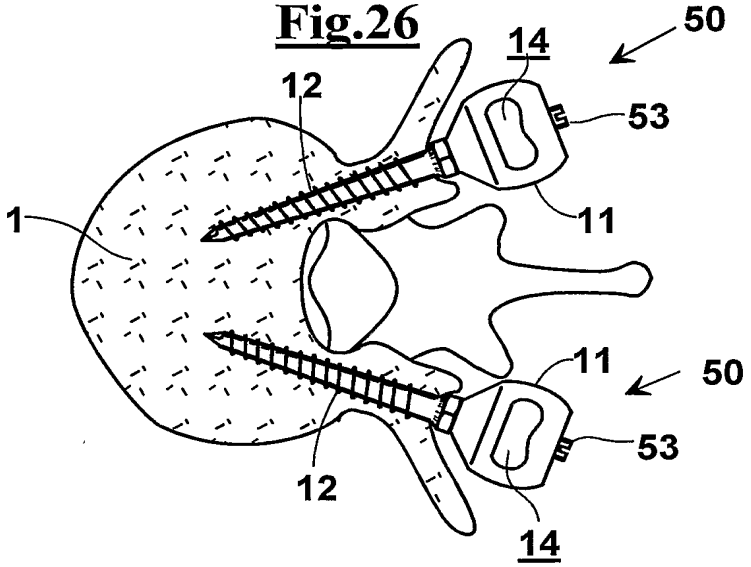

Fig.27

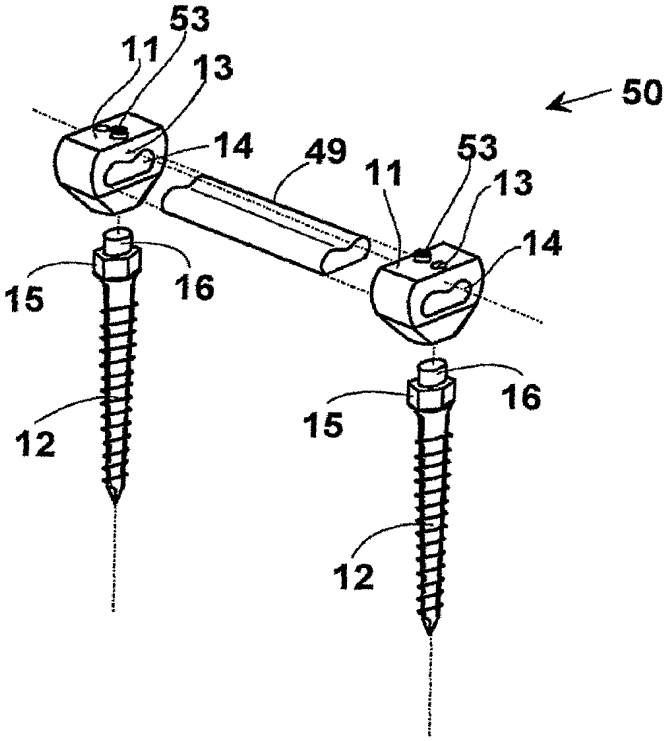
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Fig.28

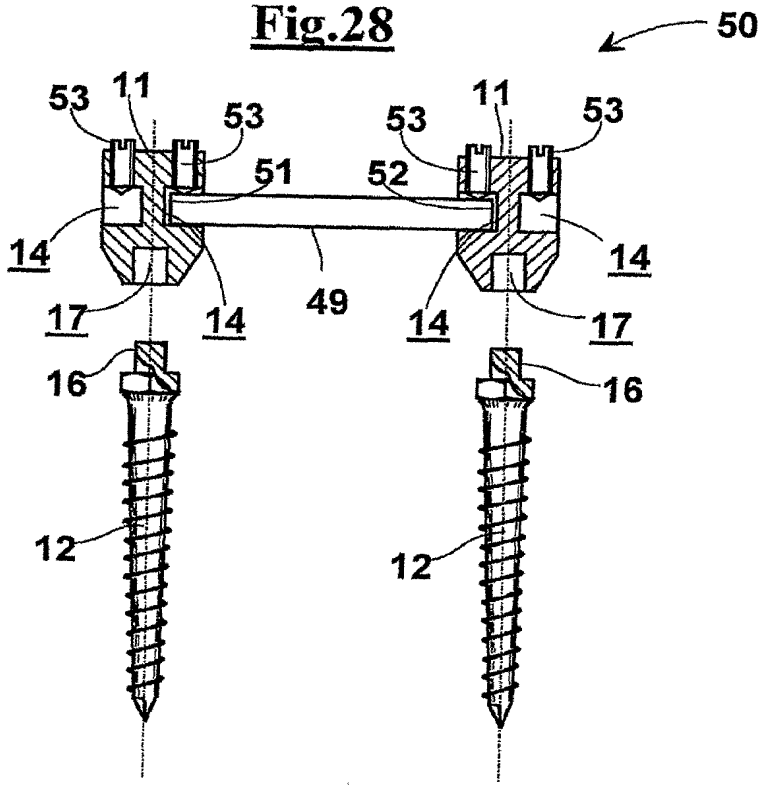
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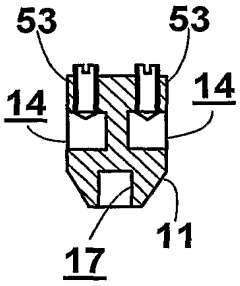
Fig.29



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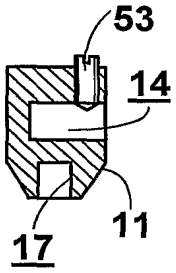


Fig.31

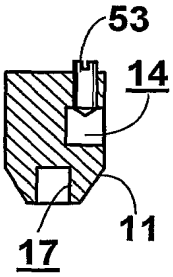


Fig.32

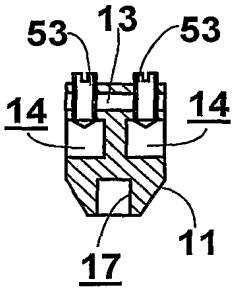


Fig.33

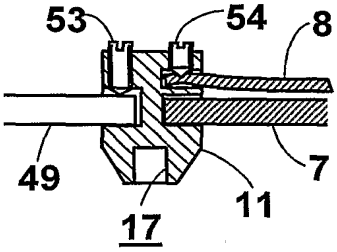


Fig.34

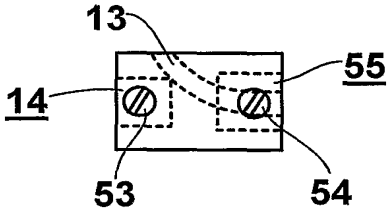
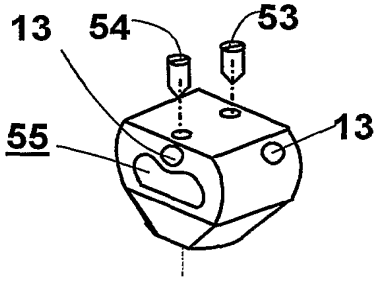


Fig.35



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(54) Title: MODULAR VERTEBRAL STABILIZER

(57) Abstract: Stabilizer (6) of the spinal column adapted to connect to each other at least two adjacent vertebrae (1 and 2) using flexible connection elements that allow for some limited motion to the vertebrae and/or stiff connection elements. The stabilizer (6) comprises an elongated block (7) of predetermined length having two ends operatively connected or compressed between the heads (11) of two screws (12) connected to adjacent vertebrae (1 and 2). The head (11) can be obtained separated from the screw (12) and the head (11) and the screw (12) can be componible together through engaging means. The block (7) can be stiff or flexible. The head (11) can have a first through hole (13) adapted to house a resilient tie-member (8) connected between two heads (11) and adapted to keep the block (7) in position. The head (11) can have a second through hole, at an angle with respect to the first hole (13), said second hole being adapted to house a transversal tie-member connecting diagonally with respect to the spinal column the heads (11) of two screws being applied to two consecutive vertebrae (1 and 3).

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INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2006/003342

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61B17/70 A61B17/86

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A61B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2004/111088 A1 (PICETTI GEORGE D [US] ET AL) 10 June 2004 (2004-06-10) paragraph [0031] - paragraph [0034]; figure 5	1,2,5
X	US 2005/154390 A1 (BIEDERMANN LUTZ [DE] ET AL) 14 July 2005 (2005-07-14) paragraph [0111] - paragraph [0114]; figure 6a	1,2
Y	EP 0 669 109 A1 (SULZER MEDIZINALTECHNIK AG [CH]; PROTEK AG [CH] SULZER ORTHOPAEDIE AG) 30 August 1995 (1995-08-30) cited in the application the whole document	1-3,5,6, 8,10,12

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 May 2007	01/10/2007

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Nistor, Loredana

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2006/003342

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2005/059972 A1 (BISCUP ROBERT S [US]) 17 March 2005 (2005-03-17) paragraph [0015] paragraph [0070] - paragraph [0073]; figures 1,2	1-3,5,6, 8,10,12
A	EP 1 430 846 A1 (BIEDERMANN MOTECH GMBH [DE]) 23 June 2004 (2004-06-23) paragraph [0021] - paragraph [0034]; figures 5,6A-6C	1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2006/003342

Box II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

see annex

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-14

   A vertebral stabilizer comprising an elongated block, a screw having a head and means for keeping the block at a predetermined distance between two heads, the head being separated from the screw.

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2. claims: 15, 17

   A vertebral stabilizer comprising an elongated block, a screw having a head and means for keeping the block at a predetermined distance between two heads (a resilient flexible tie-member cooperating with a first hole in the head), the head comprising at least a second hole at an angle inccident with respect to the first hole.

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3. claim: 16

   A vertebral stabilizer comprising an elongated block, a screw having a head and means for keeping the block at a predetermined distance between two heads (a resilient flexible tie-member and a first hole in the head), the tie-member being external to said block.

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2006/003342

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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